Global Clusters of Innovation:
Lessons from Silicon Valley

Jerome S. Engel

Can innovation and entrepreneurship stimulate economic growth in diverse communities, or is it only effective in a few unique places like Silicon Valley? This article identifies the salient components, behaviors, and linkages that characterize Silicon Valley and explores how these characteristics apply in a diverse selection of economic communities in Europe, Asia, and Latin America. It focuses on the role institutions—such as governments, universities, major corporations, and NGOs—play in shaping such communities. It provides insights for government policy makers on how to enhance their region's innovation potential, and offers strategies for entrepreneurs and venture investors as to how to leverage the benefits of clusters of innovation, wherever one is located. (Keywords: Economic Growth, Entrepreneurship, Innovation, Technological Innovation, International Business, Venture Capital, Silicon Valley, Startups)

The process of innovation and how it applies to modern regional economic development is a major driver in efforts around the world to improve the economic vitality and competiveness of communities, regions, and nations. It is broadly touted that the right combination of factors and policies can unleash the inherent entrepreneurial capacity of society, energize individual initiative, and create individual and collective benefit. However, the success of efforts to create innovation clusters has been uneven at best, and the regional economic scene is littered with Silicon Valley imitators. In an effort to capture the lessons of effective innovation clusters and the challenges of those still emerging, 20 entrepreneurship educators, civic leaders, and practitioners came together to investigate a generalized framework derived from the Silicon Valley ecosystem and to consider how it applies in diverse settings around the world.[1] The investigators were each active participants and initiative leaders in their settings, which gave them the ability to discern subtle qualitative attributes of their respective contexts that may not be readily evident from traditional data analysis.

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A number of general lessons and strategies for emerging innovation economies were derived from these cumulative observations—valuable for governments and policy makers, as well as for entrepreneurs, investors, corporate executives, university and research center administrators, and others interested in innovation clusters and regional development.

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What is a Cluster of Innovation?

Clusters of Innovation (COI) are global economic "hot spots" where new technologies germinate at an astounding rate and where pools of capital, expertise, and talent foster the development of new industries and new ways of doing business. They are vibrant, effervescent ecosystems composed of startups, businesses that support the startup process, and mature enterprises (many of whom evolved rapidly from a startup history). In these ecosystems, resources of people, capital, and know-how are fluidly mobile and the pace of transactions is driven by a relentless pursuit of opportunity, staged financing, and short business model cycles.

A Cluster of Innovation is similar to, but somewhat different from, the well-established understanding of a business cluster. In 1990, Michael Porter described business clusters as geographic concentrations of a critical mass of interconnected companies and institutions in a particular field "whereby proximity leads to shared advantages through the aggregation of expertise and specialized resources."[2] This concept of clustering explains how areas specializing in a particular industry gain competitive advantages through economies of scale and reduced transaction costs, but it does not explain how highly innovative clusters are able to support the continuous emergence of high-growth firms, some of which diverge from the original business concentration. For example, why did a cluster of high-growth biotech firms emerge in the matrix of semiconductor and computer firms in Silicon Valley rather than in the pharmaceutical industrial cluster of Philadelphia/northern New Jersey?

Innovation-centered business clusters began to gain more attention in the 1990s, particularly through the work of AnnaLee Saxenian, who described the divergence of two successful models for an innovation cluster, Boston and Silicon Valley, and who insightfully forecasted the eventual dominance of Silicon Valley.[3] The term "cluster of innovation" began to come into more common parlance, but still lacked discrete definition.

In 2009, Engel and del-Palacio extended Porter's definition of industrial agglomeration to delineate a Global Cluster of Innovation Framework that describes business clusters defined not primarily by industry specialization but by the stage of development and innovation of the cluster's constituents. While industry concentrations do exist, they are not definitive. It is rather the nature and the behavior of the components that is distinctive—the rapid emergence of new firms commercializing new technologies, creating new markets, and addressing global markets.

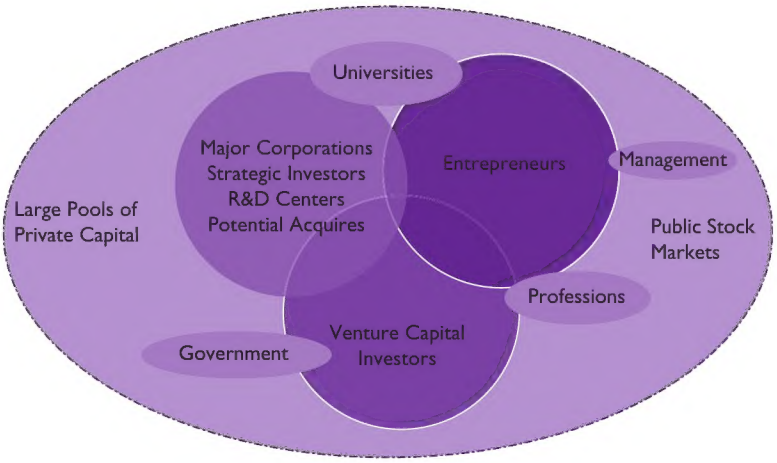
Focusing on Silicon Valley, the archetype of such a cluster, Engel and del-Palacio identified key components that define these aggregations: entrepreneurs,

venture capital investors, mature corporations and strategic investors, universities, government, R&D centers, and specialized service providers and management. They also distinguished key behaviors in these environments that favor the development of high-potential entrepreneurial ventures: a heightened mobility of resources (principally people, capital, and information—including intellectual property); an entrepreneurial process (the relentless pursuit of opportunity without regard for resource limitations); increased velocity of business development; a strategic global perspective; a culture of alignment of interests and transaction structures that reinforced that alignment; incentives and goals that lead to an affinity for collaboration; and development of global ties and bonds.[4] In 2011, they further investigated the types of relationships that develop between COI, the affinity for inter-COI collaborations (Global Networks of COI), and the emergence of instances of closely interrelated remote COI (Super-COI).[5]

Figure 1 presents a graphic representation of how the key components function together in an innovation-centered business cluster.

The Global Networks of COI Framework was utilized in this investigation: first as a basis of comparison to more fully elucidate how the archetypal Cluster of Innovation, Silicon Valley, functions; and secondly, as a tool for understanding the actors and interactions in the 12 additional economic regions profiled. We hypothesized that the same components and behaviors would appear to some degree in all regions, but that different configurations might be present, with some components being more prominent than others in various clusters and with different trajectories in the development (or re-development) of key behaviors. Of principal interest is to identify and evaluate the impact of interventions that governments and other institutions take to stimulate the evolution of innovation

FIGURE 1. The Innovation Engine of Clusters of Innovation



Source: Developed by author, 1995. Published in J.S. Engel, *Global Clusters of Innovation: Entrepreneurial Engines of Economic Growth around the World* (Northampton, MA: Edward Elgar Publishing Inc., 2014). By permission of the publisher.

clusters. We also hypothesized that the lessons learned from innovation cluster initiatives and experiences in different regions would provide valuable insights and strategies for actors in emerging innovation economies.

If Silicon Valley is the Archetype, What Makes it Tick?

Many of the contributors to this investigation met together in 2011 and again in 2012 to discuss how innovation clusters were evolving in their regions and to map their observations against the Global Clusters of Innovation Framework. They began by taking an in-depth look at how Silicon Valley emerged, what institutions fostered its development, and how it functions today. The Framework delineates the key components of a Cluster of Innovation and differentiating behaviors of those components. Accordingly the investigators captured their observations in that frame.

COI Components in Silicon Valley

Three components—universities, government, and entrepreneurs—played key historic roles in the transformation of this small agricultural valley into the powerhouse of invention and business creation that now extends north into San Francisco and the East Bay corridor.

Universities

Founded in the late 19th century, the University of California at Berkeley (along with its offspring campus, UC San Francisco) and Stanford University in Palo Alto were both initially grounded in practical disciplines such as agriculture, mining, and mechanics. In the early 1900s, however, these universities expanded to integrate business and education, with Stanford taking the lead in commercialization of telephone, electronics, and computer technologies. The universities' open collaboration with private industry helped early high-tech firms flourish and continues in this role today. In 1951, Professor Fred Terman spearheaded creation of the Stanford Industrial Park (now Stanford Research Park), in cooperation with large corporations such as General Electric, IBM, Eastman Kodak, Lockheed, Varian, and Hewlett-Packard. Today the Park is home to more than 150 companies, with over 23,000 employees in electronics, software, biotechnology, and other high-tech fields.

Government

A second major player in the early development of Silicon Valley was the United States government. Starting with the run-up to World War II and continuing through the Cold War, military research funded engineering efforts in universities (electronics at Stanford and high-energy physics at UC Berkeley), national government laboratories (Lawrence Berkeley and Lawrence Livermore National Laboratories and the Stanford Linear Accelerator), and private firms in Silicon Valley.

Military contracts helped build nascent corporations that were to become pillars of Silicon Valley, including Hewlett-Packard and Varian. During the Cold

War and Space Race, Lockheed Missiles and Space became the largest employer in the Valley. This long-term governmental spending on military weapons and aerospace R&D in the Valley can be considered as a crucial catalyst for the subsequent emergence of this techno-centric innovation cluster.

Government policy has also played a large role in fostering the growth of Silicon Valley. In 1980, a shift in Federal government policy (the Bayh–Dole Act or Patent and Trademark Law Amendments Act) permitted universities to pursue ownership of their inventions in preference to government ownership of the patents.[6] This transfer of commercialization rights released a font of potential opportunities for entrepreneurs and investors and kick-started a new wave of commercialization of government research, not funded directly by the government but rather by private investors.

Entrepreneurs

The work force is not only highly educated and technically skilled, but extremely innovative and entrepreneurial. In 2010, the ZIP code 95054, in the heart of the Silicon Valley, produced the most industrial patents of any ZIP code in the U.S. With over 20,000 patents, it ranked 17th compared to all nations globally.[7] Startups, and the entrepreneurs that drive them, are often highlighted in popular culture. Apple (Jobs and Wozniak), Google (Page and Brin), and Facebook (Zuckerburg) have become cultural icons.

This entrepreneurial spirit evolved from California Gold Rush days, when adventurous individuals turned their attention to other enterprises in the Bay Area. What differentiated these entrepreneurs was their willingness to take big risks in return for big gains. This spirit continues today. Silicon Valley entrepreneurs seek opportunities for big potential upsides and are willing to use outside equity capital financing in pursuit of these gains. This outside capital comes at a high price, but may unlock significant potential. It dilutes entrepreneurs' ownership and control, and biases business strategy to strive for big wins, enabling a sale of some or the entire venture to provide the investors an appropriate return on capital. Rather than retaining control of their venture, Silicon Valley entrepreneurs often recycle themselves (and their wealth and their relationships) into subsequent startups. Such "professional entrepreneurs" are core actors that drive Silicon Valley's continuous self-reinvention with new industries and technologies.

Other COI Components in Silicon Valley

Other significant COI components evolved in Silicon Valley as it developed.

Venture Capital

Investments in early Silicon Valley startups, such as Shockley Semiconductor Labs and Fairchild Semiconductor, were provided by operating corporations, not investment firms. With the first IPOs of Silicon Valley startups (Varian in 1956, Hewlett-Packard in 1957, and Ampex in 1958), professional venture capital investors appeared—investing their own capital in early-stage companies, as well as funds from large institutional investors such as pension funds. Venture capital investors have provided critical capital to nascent companies—in the last decade

VC investment in the U.S. has been $26-30 billion per year with one-third or more regularly invested in Silicon Valley.[8] The structure of VC firms (e.g., carried interest compensation, staged financing, and limited fund life) and VC investments (e.g., preferred stock for investors with economic and control preferences) influence behavior in Silicon Valley, driving startups to rapid value creation, scaling, and early exit. Venture investors also have helped accelerate innovation through active involvement in governance, recruiting, and the creation of compensation policies (such as the broad diffusion of incentive stock options) to help align the economic interests of all employees with the economic interests of the investors. An early example of what helped cement this pattern was the Apple IPO that instantly created over 300 millionaires among its employees.[9]

Mature Corporations

Many of Silicon Valley's best known global enterprises (such as Intel, Apple, Cisco, Google, and Genentech) are recently birthed entrepreneurial firms that recognize the benefits of collaboration with emerging firms. Collaborations between mature corporations and startups can take many forms, from simple contractual agreements to equity investments, partnerships, and acquisitions.

Industrial Research Centers

As Silicon Valley expanded, so did the bounty of research centers. In addition to Federally funded research labs, many major corporations also created R&D centers either because they were headquartered in the Valley (like Hewlett-Packard or Cisco) or because they wanted their researchers close to the center of innovation and commercialization (like IBM, Xerox, and Samsung). This trend continues with recent imports including Walmart and Baidu research centers. Other independent R&D centers spun out of university relationships, such as Stanford Research Institute (SRI). In addition to providing the Valley a deep reservoir of top technical talent, these centers spark new ventures as engineers and scientists seek entrepreneurial outlets for themselves and their projects.

Service Providers and Management

The needs of large numbers of cash-starved, high-potential startups led to the development of specialized service providers (such as lawyers, accountants, design professionals, recruiting firms, investment bankers, incubators, and accelerators) who not only provided tailored professional services, but also are willing to discount or defer fees, often in exchange for a small share in the venture's eventual returns. Similarly, a professional entrepreneurial management class evolved to enable the rapid scaling of young ventures. These managers are highly regarded individuals who specialize in working with startups of a certain size or stage, where their functional expertise (i.e., product development, finance, engineering, sales, and marketing) is primary, with industry-specific experience secondary. Their career paths are marked by serial positions in a number of startups, where they bring the relevant experience that accelerates growth.

Components of a Cluster of Innovation are summarized in Table 1, with a few examples demonstrating how these are manifest in Silicon Valley.

TABLE 1. COI Components: Silicon Valley (*continued on next page*)

COI Components	Manifestations in Silicon Valley
Universities	▪ Major research universities (e.g. University of California, Berkeley and San Francisco; Stanford University) are sources of new technologies and inventions
	▪ Universities support commercialization of technology with entrepreneurship education, incubators, seed funding, etc. (e.g. Berkeley-140 startups from university inventions, 65 funded at average $13.8M each, 1988-2012; Stanford- 8,961 patents and 2,770 spin-off companies, 2006-2010.)
	▪ 30 other colleges and universities in Bay Area provide ongoing pool of talent
Government	▪ Provides transparent rule of law (including property rights) and safe, stable society
	▪ Military contracts for radio & radar defense at Stanford led to growth of pillar SV companies such as Hewlett-Packard, Varian, Lockheed Missiles and Space, providing foundation for future techno-centric innovation cluster
	▪ Federally funded research labs e.g.Lawrence Berkeley National Laboratory – central role in nuclear physics; and now in interdisciplinary research; home to 13 Nobel Laureates; spun off 30 startups, 2000-2010, creating 2400 jobs (13,000 jobs indirectly).
	▪ Policies, such as Bayh-Dole Act of 1980, which gave invention ownership to universities instead of government, foster spin-offs from government-sponsored research
Entrepreneurs	▪ Omnipresent and oriented to managing big risks for big gains, with goal of creating new ventures and rapidly scaling to become major enterprises
	▪ Utilize outside equity capital to achieve this goal, often requiring early sale (or public offering) of company to provide appropriate returns to investors
	▪ Successful entrepreneurs often recycle themselves and their wealth into other startups
	▪ Startups (and the entrepreneurs that drive them) are popular culture icons
	▪ Different from owner/operator perspective of entrepreneurs in many economies that focuses on local or regional "family" business not dependent on outside risk capital and therefore not pushed to rapid value creation and realization
Venture Capital	▪ Provides conduit for major institutional investors, such as pension funds and endowments
	▪ Provide institutional structures, such staged financing and fixed fund life that help investors manage risk and drive the pace of transactions and value creation
Mature Corporations	▪ Many leading SV firms are relatively young, entrepreneurial in background and outlook, and open to collaboration with startups and disruptive technologies
	▪ "Open Innovation" bias offers resources to startups and innovation acceleration to mature corporations, but requires skillful management from both sides
	▪ Different from mature corporations in industrial clusters and elsewhere that focus on incremental growth in established markets and avoidance of radical or disruptive innovations

TABLE 1. COI Components: Silicon Valley (*continued from previous page*)

COI Components	Manifestations in Silicon Valley
Industrial Research Centers	▪ Reservoirs of technical talent and outlets for scientists to commercialize technologies
	▪ Government: e.g. Lawrence Berkeley National Labs; Stanford Linear Accelerator Center
	▪ Corporate: e.g. Hewlett-Packard Labs; IBM Almaden Research Center; (Xerox) PARC
	▪ Independent: e.g. Stanford Research Institute
Service Providers	▪ Specialized providers (lawyers, accountants, investment bankers, accelerators, design, recruiting) provide specialized services and flexible fee arrangements to match startup needs
	▪ Flexible fee structures: equity in lieu of cash
	▪ Some providers make notable contributions, e.g. Frog Designs' original design for the Macintosh computer
Management	▪ Professional entrepreneurial managers specialize in building new ventures and have serial positions in multiple startups
	▪ Specialize in startups of certain size or stage; their functional expertise (product development, finance, sales, marketing, etc.) more important than industry expertise

Source: Developed by author, 1995. Published in J.S. Engel, *Global Clusters of Innovation: Entrepreneurial Engines of Economic Growth around the World* (Northampton, MA: Edward Elgar Publishing Inc., 2014). By permission of the publisher.

COI Behaviors in Silicon Valley

Of equal importance to the components of Silicon Valley's Cluster of Innovation are the behaviors and interactions among these components. Behaviors are what provide the action and create the value. The critical behaviors of a Cluster of Innovation are defined as: mobility of resources (money, people and know-how/technology); entrepreneurial processes of opportunity seeking, innovation and experimentation; taking a global strategic perspective; constructing transactions and processes that align interests to achieve collective goals; and global perspective and international linkages.

Mobility of Resources

One of the most salient characteristics of Silicon Valley is the intrinsic sense of motion that permeates the entire environment. New ventures are created and die or successfully exit. Capital, people, and knowledge/technology are continually on the move. Mobility is built into the very structures of transactions and management.

Venture capital—with staged financing just sufficient to achieve the next major milestone (typically 12-18 months) and limited fund lifetimes—drives entrepreneurs to seek out opportunities that can scale rapidly so that they can achieve liquidity within the ten-year time horizon. Deal structures have their own blends of incentives and rewards (such as multiple stock classes, vesting of founders' stock, liquidation preferences, and rights of first refusal) that encourage seeking big wins and quick exits. Capital from successful ventures is recycled into new opportunities.

People working in new ventures adopt career styles that take advantage of the temporary nature of startups. Typical compensation arrangements include equity compensation provisions, which vest over a fixed period (typically 4 years). Effective career management often entails rotating from one startup to another every three to five years in order to build a portfolio of capital return opportunities. There are myriad models of investors and entrepreneurs and managers who successfully exited from one company and used their expertise to start or invest in new companies. In addition, a high percentage of the work force is international, many of whom move fluidly between Silicon Valley and their home countries.

Knowledge and technology are similarly mobile, migrating with people from one venture to another. Technology that is protected by intellectual property rights (IP) is often accessed through licensing agreements with universities and corporations. Some corporations are experimenting with spin-outs and out-licensing to harvest value from non-core technology assets. Many major enterprises have corporate venture activities, active startup acquisition programs, and other "open innovation" processes that promote mobility of ideas and inventions.

Entrepreneurial Process

The entrepreneurial process is "the relentless pursuit of opportunity without regard for limitations imposed by the resources under one's control."[10] In Silicon Valley, this translates to continuous and rapid innovation (often capitalizing on technology commercialization), business model experimentation, and new market creation. Hierarchal structures and titles are less important than team processes and flexible leadership. The learning cycle is fast-paced and formal planning is often displaced by short-cycle experiments, as recently manifested in the Lean Startup movement. Unlike traditional managers, entrepreneurs must succeed in conveying a vision of the enterprise that will secure sequential rounds of funding, talent, and resources. This activity requires a relentless pace that syncs cash consumption, achievement, and recruitment in a virtuous cycle and in a context where all understand that failure is a possible and perhaps probable outcome.

Global Strategic Perspective

The need to provide outsized returns rapidly leads entrepreneurs to focus on large markets, often using "beachhead" strategies of seeking to open new markets where there is little competition and where the need is so compelling that high margins can be realized.[11] An example is Raytheon's initial commercialization of the early transistor by offering hearing aids, which paved the way for dominance in the broader electronic device market as semiconductors displaced the vacuum tube. A current example is Tesla Motors, whose initial product was a high-performance sports car targeted at a tiny segment of the market, paving the way for mainstreaming with its Model S sedan and Model X sport utility vehicle. The pursuit of large markets also leads entrepreneurs to look globally for opportunities, financing, talent, and resources. Startups are said to be "born global" when they consider from inception the use of international resources and markets.[12]

Alignment of Interests, Incentives, and Goals

With all this mobility, how do ventures retain continuity and control of crucial resources? The investment structures of venture capital align investors, entrepreneurs, management, and employees to strive for big wins. Silicon Valley has evolved employment and compensation methodologies that link employees' rewards to the collective success of the enterprise, thus aligning employees' interests with those of the business. The benefits of such a system are apparent to employees throughout the community when successes such as Twitter create over 1,600 millionaires upon its IPO.[13] Enterprises and individuals in Silicon Valley also benefit from a web of shared values, business practice, and culture. Although the innovators compete with each other, they participate together in a win-win challenge to displace existing incumbents and introduce new solutions. Similarly, venture capitalists share deal flow and co-invest as a regular practice in spite of fierce competition among firms.

Global Ties and Bonds

International linkages contribute significantly to Silicon Valley's vitality. In the Global Cluster of Innovation Framework these connections have been categorized as *weak ties, durable bonds,* and *covalent bonds.*

In Silicon Valley, weak ties are easily exemplified by the networks found in immigrant communities, especially among the Indian, Chinese, and Israeli engineers and scientists who have evolved their own professional networks. They also are also connected into their home countries' networks through alumni associations and family ties,[14] and sometimes return to their home countries to pursue opportunities while continuing professional ties in the United States. Where previously immigration to the U.S. signaled a "brain drain," it is now more broadly recognized as an opportunity for "brain circulation."

Sometimes weak ties support the formation of long-distance business relationships, such as contracts or employment relationships, which permit frequent and fluid mobility of assets and people with relatively low transaction costs. These durable bonds not only provide the advantages of traditional business clusters (such as aggregation of expertise, economies of scale, and access to customers), but also provide avenues for rapid sharing and adapting to new knowledge and technology.

When connections between clusters are strong, the pursuit of shared projects and utilization of resources go beyond efficiency to mutual dependency. Such communities are often linked by individuals who establish and maintain presence in both clusters simultaneously. Such individuals act as covalent bonds, enhancing trust, reducing transaction costs, and accelerating information exchanges. Businesses in one cluster become embedded in the business and processes of the other, manifesting unified values, tight interrelationships, and business integration.

When sufficient weak ties, durable bonds, and covalent bonds connect two COI, they come to share common business practices and operate in a highly efficient fashion such that even though they are geographically remote, they can be characterized as operating as a single cluster (a Super-COI). One well-documented

Super-COI is the Silicon Valley/Israel high-tech connection.[15] Such inter-COI bonds often evolve out of the circular migrations of immigrant entrepreneurs.

Behaviors in a Cluster of Innovation are summarized in Table 2, with a few examples demonstrating how these are manifested in Silicon Valley.

TABLE 2. COI Behaviors: Silicon Valley (*continued on next page*)

COI Behaviors	Manifestations in Silicon Valley
Mobility of Resources	▪ Money: recycling of capital and alignment of interests is strongly influenced by VC practices and structures that support scaling high risk ventures and then exiting through M&A or IPOs (e.g. front-end commitment of financing to VC funds, limited fund life, staged funding of ventures, multiple stock classes with different rights, equity compensation, vesting provisions); investors and serial entrepreneurs recycle their profits into financing new ventures
	▪ People: environment attracts a trained work force from all over the world (e.g. in 2013 36% of the Valley population was foreign-born); equity compensation structures (e.g. incentive stock compensation, vesting typically at 4 years) encourage entrepreneurs & employees to frequently move to new ventures, taking an investors perspective, accumulating portfolios of potential equity returns
	▪ Know-how/Technology: protected IP is often licensed from universities or from major corporations (when technology is not related to main corporate business); startup acquisitions and spin-outs from some corporations also promote mobility of IP and know-how; informally, knowledge and know-how naturally migrates with people;
Entrepreneurial Process	▪ Relentless pursuit of opportunity in technology commercialization, business model experimentation, and new market creation
	▪ Team process and flexible leadership more important that hierarchical structures
	▪ Entrepreneurship is managing a resource-deficient context, with progress dependent on recruiting people, capital and other resources; entrepreneurs are on continual quest to feed their venture's engine of value creation
Global Strategic Perspective	▪ Focus on large market opportunities, often requiring initial niche market "beach heads" to deploy new capabilities or business models, avoiding early head-to-head competition with dominant incumbents
	▪ "Born Global": from inception, looking globally for markets and resources
Alignment of Interests	▪ Mobility balanced by commitment, generated by compensation mechanisms that tie employee and founder rewards to success of the enterprise and good outcomes for venture investors
	▪ Staged financing aligns action to achieve goals, address tough problems early, reduce founders dilution and investors risk.
	▪ Inter-firm cooperation promoted by shared challenge to develop new solutions and disrupt incumbent businesses
Global Linkages among COI	▪ '*Weak ties*' of casual professional and social connections and networking (e.g. ethnic professional associations connecting immigrants in both SV and their home countries)
	▪ '*Durable bonds*' articulate business commitments, such as contracts or employment relationships that lower transaction costs and permit sharing of expertise and customers (e.g. SV outsourcing computer component production in China and SE Asia)

TABLE 2. COI Behaviors: Silicon Valley (*continued from previous page*)

COI Behaviors	Manifestations in Silicon Valley
	▪ '*Covalent bonds*' of more permanent structural relationships where entities are tightly interrelated and mutually dependent; individuals may have roles in two COI simultaneously (e.g. SV-Taiwan interdependent PC and semiconductor clusters)
	▪ '*Super-COI*'- two geographically separate COI that have sufficient ties and bonds to be characterized and function as a single cluster, such as the Israel/Silicon Valley high- tech COI. Circular migration of immigrant entrepreneurs favor this type of linkage.

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Is Silicon Valley Relevant as a Guide to Emerging Innovation Economies?

Having probed the essential characteristics of Silicon Valley as the archetypal Cluster of Innovation, this investigation returned to a primary question: Does Silicon Valley have worldwide relevance? This study[16] examines the makeup of innovation communities in diverse settings around the world, probing the role and behaviors of key players (such as institutions, organizations, corporations, and universities) to identify how individual actors in an ecosystem contribute to its overall progress. Then it compares those communities with the trajectory of Silicon Valley and reveals lessons, insights, and strategies that may be useful for emerging innovation economies.

The investigation takes us on a tour of 11 countries and 13 distinct economic regions. The regions were not chosen to represent the best examples of innovation ecosystems, but rather as cases where varying preconditions, government policies, and geographic factors created diverse approaches and outcomes. Some are highly evolved mature innovation clusters with multiple industry foci.[17] Some are specialized in a single industry,[18] and sometimes in a single aspect of that industry (e.g., manufacturing, or early stage product and business model design).[19] Some reside in large domestic markets,[20] and others in smaller, export-dependent regions or countries.[21] Some are in societies where the enabling factors are strengthening,[22] and others are stumbling under the burden of failing foundational elements.[23] Some have recently evolved from distressed situations, and others continue to face severe challenges.

Why such diversity? Because context matters. Different societies are facing different challenges. A major reason why efforts to transplant the ecosystem of Silicon Valley to other locations have not been successful is that the local context—key players, economic strengths and weaknesses, political realities, and cultural norms—have been ignored rather than incorporated.

Within each region, we looked at what is working and what is not, best practices and pitfalls to be avoided. With our academic participant-observers as guides, we examined the contexts, challenges, and interventions responding to the challenges in each region, which are briefly summarized in Tables 3 and 4.

TABLE 3. Case Studies in Europe and Middle East (*continued on next page*)

Economic Region	Context, Challenges & Interventions
Munich, Germany (Helmut Schönenberger, *Co-founder and Managing Director of Unternehmer TUM, the Center for Innovation and Business Creation, Technical University of Munich, Germany*)	**Context**: Munich experienced entrepreneurial booms in late 1800s and post WWII, birthing global firms like BMW, Siemens, Allianz **Challenge**: Despite ongoing economic prosperity, Munich has not sustained production of high-growth "born global" companies **Intervention**: ▪ Government-financed initiatives at Technische Universität München(TUM) and donor-backed, self-financed entrepreneurship center (UnternehmerTUM) provide spin-out support, entrepreneurship education, seed financing, industry and global linkages ▪ Consortium of 4 Munich Universities (4Entrepreneurship) shares best practices and offers training & incubation programs to the 100,000 university students in Munich
Belgium (Wim De Waele, *Chief Executive Officer of iMinds, Ghent, Belgium* and Sven De Cleyn, *Incubation Programs Manager at iMinds, Ghent, Belgium*)	**Context**: An early leader in the Industrial Revolution, Belgium switched to a service economy and market entry for multinational companies **Challenge**: Disinvestment and relocation of multinationals in 1960s left economy dominated by local SMEs **Intervention**: Flemish regional government established non-profit strategic research organization iMinds to fund technology commercialization collaborations between universities and industry and to support participation in global markets
London, UK (Itxaso del-Palacio, *Teaching Fellow in Entrepreneurship at University College London and Investment Analyst at EC1 Capital, London, UK* and Dave Chapman, *Deputy Head of the Department of Management Science and Innovation, University College London, UK*)	**Context**: Historically a center for trade and finance, London continued economic vitality even during periods of economic stagnation in the UK; in the last decade a vibrant high-tech center has grown organically in East London; supported by existing financial and university institutions and fueled by highly skilled international immigrants, this cluster exhibits many COI characteristics **Challenge**: Current needs are bridge capital, experienced investors, UK exit opportunities (acquisitions & IPOs) **Intervention**: Government's role has been minimal, reforming visa & IP laws and providing some funding and tax breaks for early stage investors. Universities and corporates can play a role in addressing needs
Barcelona, Spain (Josep M. Piqué, *CEO of the Office of Economic Growth, Barcelona City Council, Spain* and Montserrat Pareja-Eastaway, *Associate Professor, University of Barcelona, Spain*)	**Context**: Barcelona was 'the Catalan Manchester' in late 1800s/early 1900s, with manufacturing in industrial neighborhoods (e.g. Poblenou) **Challenge**: Migration of industries to city periphery in 1970s/1980s left these neighborhoods marginalized and economically degraded **Intervention**: City government urban renewal during 1992 Olympics and later in creation of 22@ "innovation district" has revitalized Poblenou and made it a model for "smart city" redevelopment

TABLE 3. Case Studies in Europe and Middle East (*continued from previous page*)

Economic Region	Context, Challenges & Interventions
Israel (Orna Berry, *Formerly Chief Scientist, State of Israel. Currently Corporate Vice President Growth and Innovation, EMC Centers of Excellence EMEA and the US, Herzliya, Israel* and Daniel Wasserteil, *Economics Consultant and Entrepreneur, Tel Aviv, Israel*)	**Context**: Since 1990s Israel has been strongest high-tech cluster outside USA; the cluster exhibits many COI characteristics; Israel's entrepreneurial culture and skilled immigrant population, government defense and civilian R&D funding, and local VC industry contribute to its success **Challenge**: Vulnerable to global economic downswings because of reliance on exports and foreign capital. Many of the best entrepreneurial startups migrate overseas or are acquired early. Failure to create large domestic companies (related to lack of bridge capital) and recent government decrease in funding of research and education **Intervention**: Government intervention is needed to expand higher education budget, diversify high-tech sector, and provide resources/reduce risks for growth of larger companies

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TABLE 4. Case Studies in Asia and Latin America (*continued on next page*)

Economic Region	Context, Challenges & Interventions
Japan (Shigeo Kagami, *Professor and General Manager of the Office of Innovation and Entrepreneurship, Division of University Corporate Relations, University of Tokyo, Japan*)	**Context**: Post WWII, birth of global firms like Panasonic, Toyota, Canon, Sony and Honda **Challenge**: Last 20 years are "lost decades" with minimal economic growth and dearth of new innovative companies; cultural, educational, legal and financial factors hinder entrepreneurial activity **Intervention**: ▪ In 2000s national government identifies entrepreneurship as vehicle to restart economy and universities as drivers of innovation; universities made financially independent from government and given IP rights ▪ As model, University of Tokyo develops Innovation and Entrepreneurship Office that facilitates entrepreneurship education, technology transfer, and seed funding; partners with private donor to create incubation facility
Taiwan (Chao-Tung Wen, *Professor at the Graduate Institute of Technology and Innovation Management, National ChengChi University, Taipei, Taiwan* and Jun-Ming Chen, *National ChengChi University, Taiwan*)	**Context**: In 1970s, aided by returning expats from Silicon Valley, Taiwanese government invests in technology development and forms linkages with SV firms to become leading personal computer and semiconductor manufacturer; government ban on videogames inadvertently fostered PC and semiconductor industry growth Linkages between US and Taiwan companies progressed from contracts to cooperative and independent product development; to reduce costs, Taiwan companies move production to mainland China **Challenge**: Increasing competition in linkages with SV and in IT manufacturing from China and SE Asia threaten Taiwan's niche in value chain

TABLE 4. Case Studies in Asia and Latin America (*continued from previous page*)

Economic Region	Context, Challenges & Interventions
	Intervention: Government investment to develop biotechnology industrial hub and restore educational & transactional linkages with SV
China (Virginia Trigo, *Professor of Entrepreneurship and Director of China Programs at ISCTE University Institute of Lisbon, Portugal* and Qin Lang, *Chairman of Henan Excellent Highway Engineering Company Ltd., Henan, China*)	**Context**: Explosive growth of private enterprises since opening of Chinese economy in 1978 **Challenge**: Lingering restrictions on financing and market entry for private business and policies favoring large, state-owned companies force entrepreneurs to rely on family-financing and maintaining social and political relationships (guanxi); gap between official policies favoring private enterprise and lack of local implementation **Intervention**: Creative entrepreneurs work around limitations, leveraging networks and innovative business models; with or without government support, entrepreneurs are looking to clusters to transform China's production patterns through global interconnectedness and innovation
Medellin, Colombia and Monterey, Mexico (Carlos Scheel, *Professor Emeritus and Former Director of the Graduate School of Digital Technologies at the Monterrey Institute of Technology and EGADE Business School, Monterrey, Mexico*)	**Context**: Many Latin American regions face underlying challenges to healthy economic development: e.g overexploitation of resources with minimal value return; lack of uncorrupted and transparent rule of law; lack of trust & ability to align interests; misguided transplants of developed-nation models; disregard for social welfare and environmental resilience **Challenge**: Medellin and Monterrey are examples of two cities, both leading industrial and commercial centers in the 20th century, who faced severe economic decline due to drug cartel warfare (1980s in Medellin; mid 2000s in Monterrey), ineffective and corrupt government, and exodus of talent and capital **Intervention**: ▪ **Medellin**: 2002-5 Colombian military disbanded drug militias; subsequent partnership of city government, universities and private industry created industrial district with research technology park; city invested in public transport and services; in 2013 CitiGroup selected Medellin as "most innovative city in the world" ▪ **Monterrey**: Recent government investment in public safety, infrastructure, and job development is improving quality of life; state and city government initiative with private sector (I2T2) to align stakeholders in shifting to knowledge-based economy **Continuing challenge**: Can these successes be sustained under continued external threats and weak rule of law?
Recife and Minas Gerais, Brazil (Flavio Feferman, *Lecturer, University of California, Berkeley*)	**Context**: Robust economic growth 1968-74, followed by recession and then solid recovery with Real Plan of inflation control in 1990s; national government played active role, with regional economic development agencies, large state enterprises, and incentives for foreign investment **Challenge**: National institutional gaps, known as the *custo Brasil* (high financing costs, complex regulatory environment, high taxes, skills gaps, corruption, and poor infrastructure) hamper business creation; dependence on national government spending hinders transformative regional development

TABLE 4. Case Studies in Asia and Latin America (*continued from previous page*)

Economic Region	Context, Challenges & Interventions
	Intervention: ▪ **Recife Porto Digital Cluster**: with World Bank funding in 1997, Northeast states launch clusters initiative with IT cluster in Recife; broad collaborative process of academia, government and private sector leads to redevelopment of historic downtown into thriving urban technology park with public spaces and services; governance by broadly representative non-profit insures independence and sustainability ▪ **Minas Gerais Cluster**: Contrasting governance model, without broad collaboration of stakeholders and financially and politically independent institutions, manifests fragmented development and limited coordination among firms, academia and government

Source: Developed by author, 1995. Published in J.S. Engel, *Global Clusters of Innovation: Entrepreneurial Engines of Economic Growth around the World* (Northampton, MA: Edward Elgar Publishing Inc., 2014). By permission of the publisher.

Some generalities became obvious in our explorations. In some ecosystems, the underlying conditions for entrepreneurship and innovation were generally favorable, as in Munich, Belgium, Barcelona, London, Israel, Tokyo, and Taiwan. While formidable challenges remain, relatively transparent rule of law, fair governance, established infrastructure and stable social structure provide a solid foundation for entrepreneurial development. In other ecosystems (such as China, Columbia, Mexico, and Brazil), entrepreneurs face profound institutional and societal challenges that heavily impact and sometimes overshadow the usual challenges of establishing and growing a business. Yet, in all of these societies there is a strong propensity and drive toward innovation and entrepreneurship, and a consensus that entrepreneurs and innovative companies have the potential to strengthen the economy and improve regional economic competitiveness.

In these 13 cases we saw various actors and forces at work, trying to establish or reinforce entrepreneurship and innovation in their regions. We observed top-down policy-driven efforts such as government initiatives, some of which have been very effective, some less effective or even inhibiting. We observed that change can arise from the bottom up, demand-driven by entrepreneurs and others pursuing opportunity who changed their communities as a by-product of their actions. Some investigators noted the influence of individual leaders and others noted the importance of collaboration and involving all stakeholders. Still others highlighted the importance of global linkages and dispersion of best practices in promoting entrepreneurial activity and innovative communities.

We concluded our investigation by examining two non-governmental entities who share the mission of diffusing best practice beyond individual ecosystems and fostering cross-fertilizing innovation networks. Two investigators—Phil Weilerstein of VentureWell and Manav Subodh of Intel—led this inquiry.

First, VentureWell (formerly the National Collegiate Inventors and Innovators Alliance) is a non-governmental organization (NGO) that is leading initiatives

to foster technology commercialization and entrepreneurship in public and nonprofit universities and colleges in the U.S. through experiential learning and mentorship (E-teams). It is also the conduit for government programs, such as the National Science Foundation's Innovation Corps initiative to train scientists across the country in technology commercialization, and it fosters the formation of networks and collaboration among regions through convening meetings, setting standards, giving recognition to role models, and creating formal collaboration networks. VentureWell's programs disseminate innovation cluster skills and knowledge and also connect more remote locations to centers of innovation.

Second, Intel Corporation is a global enterprise and leader in semiconductor design and fabrication, which for over ten years has supported the development of entrepreneurship and innovation competency in regions all around the world. Their efforts have extended from fostering entrepreneurship education and funding innovation with corporate venture capital to creating entrepreneurship awareness through ideation workshops for youth and adults in developed and developing countries around the world. Intel's programs not only create value and well-being in global communities, but also develop a better context, market, and future for its business. Like VentureWell, Intel serves as a curator and disseminator of best practice, but on a global scale.

Lessons Learned

Digesting the experiences and conclusions of the study participants, it became clear that the components and behaviors of Silicon Valley do have global relevance, but must be adapted to local context. Further, a series of discrete lessons and strategies emerged that should prove useful to government, policy makers, businesses, entrepreneurs, and venture investors. Lastly, critical questions and challenges to effective innovation cluster formation were identified.

Lessons for Government and Policy Makers

What can governments do to foster the creation and growth of regional and national innovation economies? Here are nine guidelines for building a Cluster of Innovation that emerged from our collective inquiry.

Build on Strengths, not Concepts

Leveraging and enhancing existing local capabilities is critical, such as London leveraging the experience and critical mass of stakeholders in the fashion, finance, and media industries; Israel leveraging its defense forces alumni's knowledge of cyber security and pre-built team structure; and the Porto Digital in Recife leveraging existing regional capabilities such as the early nucleus of successful IT firms and regional institutions that provided a strong technology base and critical mass of skilled graduates. In the case of Silicon Valley, decades of defense and aerospace spending created a seedbed for young firms to flourish at the dawn of the digital age. Many cluster initiatives fail when government attempts to engineer an entirely new cluster from scratch, directed by policy and theory. The better approach is to build upon and enhance existing local capabilities and sources of

competitive advantage. Redeveloping urban centers is often more effective than new greenfield construction. Encouraging innovation in existing businesses is often more efficient and effective than trying to attract entirely new industries. Local advantages and preconditions, no matter how favorable, still require exploitation through individual entrepreneurial, opportunity-seeking behavior.

Local Adaptation is Essential

While iconic models such as Silicon Valley can be useful for discerning attributes that contribute to a robust COI, every region is different. Policies need to be congruent with the local economic, social, political, legal, institutional, and cultural environment. Top-down policies can help articulate a vision, but government initiatives are most successful when they focus primarily on incumbent stakeholders, not on emergent elements of society and the economy. It is essential to empower and enable innovation from the bottom, building on local innovations and successes. This may require governments and other major institutions, such as universities, to experiment with eclectic approaches that do not conform to command and control practices. The vitality of a cluster is heightened when it provides rewards for naturally emergent behavior verses trying to nurture, encourage, or impose a vision. The city policies that enabled Medellin's economic recovery were based on respect for the entrepreneurial spirit of the city's inhabitants; development planners included large public and private corporations as well as local citizens, and priorities were given to education, services, and transportation to include the poorest neighborhoods as well as upgrading infrastructure and facilities in the industrial district. In China, on the other hand, articulated national policies are quite favorable to private enterprise and innovation, but these are weakly implemented on the local level, leaving entrepreneurs struggling with a morass of local politics and long-standing discriminatory practices that restrict market entry, financing, and opportunities to compete and grow their businesses. As seen in the China's last decade, the growth of private enterprise slows when favorable national policies are not adapted to local environments.

Government Has an Important Role

In every case we examined, government's influence and impact was evident whether direct or indirect, intended or unintended, beneficial or detrimental. That is not surprising. Governments have broadly embraced regional industrial cluster development strategies. Some explicit policies are massively overt, as in the makeover of an entire city district in the 22@ project in Barcelona and in the government policies and investment that created the PC and semiconductor industries in Taiwan. Some government policies are leveraged through educational and other civic institutions as in Munich, Recife, Tokyo, and the U.S. I-corps program. And sometimes government's beneficial impact comes from establishing conducive preconditions, clearly evidenced by the success of governments in Monterrey and Medellin in reversing the disruption of social institutions caused by corruption and the breakdown of public safety and the rule of law due to the emergence of powerful illegal drug cartels. Sometimes fortuitous preconditions are the unintended consequences of government action, such as the U.S. defense investments in Silicon Valley's

nascent electronics and aerospace industries in the decades preceding its emergence as a leading Cluster of Innovation. A more dramatic example is the disruption to Taiwan's nascent tech sector caused by the outlawing of video games, which left a void that permitted focusing energy and resources on capturing the opportunity to become a manufacturing powerhouse for the PC and Semiconductor industries.

In our studies we observed government be effective as a source of coordination, a convener of community, a provider of critical resources. However, government initiatives must be carefully and critically understood and monitored. Government actions can also be contradictory and contrary to the emergence of entrepreneurship and innovation. In China, for example, national policies supporting the emerging entrepreneurial sector are countered by the national and regional government's favoritism toward state-owned enterprises. Even when well-intentioned, the role of government can be stifling and overbearing, such as the regional development policies in Brazil that led rural states to depend on national government largess. Governments cannot be relied upon to provide the answers for Cluster of Innovation development, but rather they must focus on providing enabling environments and allow the answers to emerge.

Educational Institutions Can Do More Than Teach and Research

Universities and other educational institutions can be leveraged to provide leadership, support, and infrastructure cohesion in building COI; their role extends well beyond education and research. Universities have been long recognized as key components in industrial clusters for their role in training, education, and scientific research. Certainly they have been effective vehicles for government-sponsored research initiatives that lead to major commercialization successes, such as the internet. Moreover, as we see in the examples of Silicon Valley, Munich, Belgium, and Tokyo, universities can be effective catalysts and loci of entrepreneurial spin-outs, technology commercialization, and innovation community development.

Another, perhaps under-appreciated, role of the university is to institutionalize and lend credibility to the entrepreneurial process. This happens in three profound ways. First is the cultural messaging that an entrepreneurial career is an acceptable professional pursuit for a society's most capable talent. In some societies, such as China, Japan, and Germany, entrepreneurship was until recently perceived to be a risky career of last resort. Personal professional stature was reflected in the size, security, and prestige of the employer rather than the opportunity presented in founding and leading a new venture. Second, educational institutions help promulgate social values that enable entrepreneurial experimentation and creativity. Notable examples include: encouraging the acceptance of business failure as intrinsic in the entrepreneurial process and distinguishing it from personal failure; and promoting the acceptability of shared ownership among founders, workers, and investors where no party retains absolute control over the enterprise. Third is the refinement of the entrepreneurial process itself, achieved by the study and dispersion of the best entrepreneurial and venture development practices. Universities are lighthouse institutions—they have multiple ways to achieve their influence. They range from the formal education process (including courses, curriculum, and the conferring of degrees—even doctorates in entrepreneurship); to experiential non-curricular learning (including research

centers, incubators, and venture accelerators); to self-organizing activities (such as student entrepreneurship organizations and competitions).

Going beyond the influence of single institutions, collaboration among universities, whether in formal networks or casual interactions, accelerates the clustering effect. Collaboration can be awkward or impeded for institutions in a region where they naturally compete for students, resources, and recognition, as in the Minas Gerais cluster. This highlights contribution of multi-institution activities like the 4entrepreneurship initiative in Munich, the iMinds collaborations in Belgium, and the NSF/VentureWell I-Corps program. Our investigation illustrates that direct inter-university collaboration, as well as cooperation catalyzed by independent third parties such as VentureWell, promotes the alignment of interests that builds cluster vitality.

Interpersonal Networks are a Driving Force

Interpersonal networks are always important in society, but in a Cluster of Innovation they are a driving force that facilitates critical resource acquisition, including raising capital, recruiting talent, and attracting customers. In dealing with a resource-constrained environment, entrepreneurs are often hampered by information asymmetry in competition with larger firms. Strong interpersonal networks provide information, accelerate learning, facilitate exchanges, and reduce transaction frictions and costs in the face of this asymmetry. These advantages are achieved largely by trust established through relationships. They are also facilitated by the common bond among people with a shared outlook and micro-culture—essentially a tribal affinity. The importance of these "weak ties" can be seen in all cases and are explicitly illuminated in Silicon Valley, China, Taiwan, and Israel. In Silicon Valley, there is a distinctive tendency of individuals to form cross-industry horizontal networks with peers in their function. This contrasts markedly with most communities were affiliations are more likely among employees of the same company.[24] In China, the networks of family and community is an essential entrepreneurial asset, assisting entrepreneurs by providing access to shared risk pools of capital and enabling them to use informal relationships to forge strategic alliances. Taiwan's ascendance to a PC and semiconductor manufacturing hub began with ties between Silicon Valley companies and Taiwanese immigrants returning home. In Israel, the benefit of technically trained teams completing army service together and then going into business together has been well documented. Communities of innovation require fluidity and rapid iteration, both of which are facilitated by the familiarity bred from prior personal interactions and the trust engendered by these relationships.

Export-Dependent Clusters Benefit from COI Linkages

Clusters of Innovation are export-dependent when they are physically remote from (i.e., not contiguous with) target markets of sufficient scale to provide opportunity for sustained rapid growth of their constituent startups. This can occur in a large country (measured simply in geography) such as Australia, but classically happens in smaller countries such as Taiwan, Singapore, Israel, Ireland, and Portugal. Our investigation provided two examples, Israel and Taiwan, that highlight the critical importance of the COI characteristics of mobility and covalent bonds in these remote clusters. Both of these countries have integrated themselves into the global

value chain by forming "super-clusters" with Silicon Valley as a way of accessing global markets, but they have approached this linkage from opposite directions. Israel formed cohesive relationships based on product innovation and new venture creation, including not just vendor relationships, but also investment collaboration between Silicon Valley and Israeli venture capitalists. Silicon Valley collaboration was, in fact, a key component in the emergence and growth of the Israeli venture capital sector. Growth strategies often called for Israeli startups to open U.S. offices to house the senior executive, marketing, and sales operations. Israel has also emerged as a deep source of technology for global enterprises, initially through hosting of R&D centers and later through the acquisition of startups.

The Taiwan/Silicon Valley super-cluster is quite different. It was premised on manufacturing for U.S. tech companies in the PC and semiconductor industries. The linkages with Silicon Valley were formative, as the emergence of the Taiwan PC and semiconductor manufacturing sectors were the direct result of explicit support of the Taiwanese government, implementing policy based on the advice provided by Taiwanese émigrés working in Silicon Valley. Many of these émigrés later returned, bringing with them entrepreneurial expertise, access to venture capital, and relationships that facilitated cross-border relationships. As the Taiwan cluster grew, it continued on the manufacturing track, but rather than exporting product, it exported expertise and captured value by extending its manufacturing capacity to mainland China, enhancing its value as a portal to low-cost manufacturing capacity for U.S. companies. The U.S. companies then tended to evolve toward specializing in product development and marketing, thereby cementing the symbiotic core of the super-COI relationship.

Many variations on these two themes can be found in the other cases investigated. The consistent insight is that in export-dependent regions, linkages among COI can play a critical role in accessing missing COI components and fostering growth.

Clusters of Innovation Can Be the Basis for Urban Renewal

Older urban centers often face challenges of eroding infrastructure and economic vitality. Incumbent industries fail or exit as economic and trade cycles shift the center of growth to suburban or remote regions. Governments historically focus on the facilities aspect of redevelopment. Our study of Barcelona and Recife demonstrate that giving equal importance to the contents of the community can pay big dividends. Traditional enticement of commercial activity to a region focuses on the attraction of major enterprises. The 22@ initiative of Barcelona and the Porto Digital cluster in Recife demonstrate the positive and comparable contribution that can be made by focusing on supporting local emerging businesses.

Innovation clusters can drive urban renewal even without overt government planning. The high-tech clusters that have emerged in San Francisco and London demonstrate this, and the effect is apparent to lesser extents worldwide. Several factors are increasing the desirability and viability of urban clusters:

- The new media business is increasing scale and impact, with internet, mobile, and community applications converging to disrupt and rebuild the

fundamentals of the media, advertising, entertainment, and communications industries. It can be said that the finance industry is in an earlier stage of similar disruption and reinvention.

- These content-rich industries have been attractive to new startups, providing the opportunity to build enterprises of size and global significance, such as Google, Facebook, LinkedIn, and Twitter.
- Commercial urban facilities are more suitable for these industries, which do not need industrial-scale infrastructure.
- The professional knowledge workers that power these industries often prefer urban lifestyles.

This is a powerful cocktail that should catch the attention of urban planners worldwide.

Multi-National Industrial Giants Play an Important Role

Entrepreneurship literature often focuses on major global enterprises as the incumbents, targets to be disrupted by insurgent startups. As the case of Silicon Valley demonstrates, major corporations can be the "secret sauce" in a high-functioning Clusters of Innovation. They have often been a key anchor in building innovation clusters, as happened in Israel when multinational corporations opened R&D centers there, providing high-value jobs and experience for local workers, stimulating economic growth, and connecting Israel to the global economy.

In this era of "open innovation," the most progressive major enterprises recognize that collaborating with entrepreneurial startups (through contractual agreements, equity investments, formal partnerships, and acquisitions) can benefit them by: being a source of product and business model innovation (essentially an R&D farm team that allows for experimentation without committing less agile corporate resources until the time is right for acquisition); creating an ecosystem of products and services to support and enrich the user experience for core products of the enterprise (e.g., Apps for the iPhone); and functioning as a vehicle for commercializing enterprise R&D assets in markets not core to the enterprise. On the other side, partnering with large companies provides startups with access to markets, capital, other resources, and even exit strategies. It can be the critical factor to allowing them to accelerate their growth trajectories.

The case of Intel Corporation is instructive. Long active in "open innovation," Intel has had a very active corporate venture capital fund for decades. They have used venture investing as a vehicle for technology acquisition as well as ecosystem development for key products. However, Intel is also instructive in how a global corporation can have large impacts beyond "open innovation," outsourcing, and offshoring. Intel has created initiatives that support building entrepreneurship and innovation capacity globally, working in diverse communities at all levels of society, from grammar school to post-doctoral research, from the villages of the developing world to the centers of high technology in Israeli, India, and the U.S., indeed world-wide. These are not simply acts of corporate social responsibility. Rather, this effort is sincere investment in the elevation of innovation potential of humankind in recognition that this enhances opportunities to grow the market for its products

and services. This investment is certainly indirect, and can only be undertaken by truly global, forward-thinking enterprises, but it is an example of the profound effect such companies can have.

To attain a fully functioning COI, or in working to enhance one, mature enterprises must be included in the mix. In addition, progressive, forward-thinking companies can have outsized influence on the societal matrix in which COI develop.

COI Can Help Sustain Regional Competitive Advantage

The behaviors of a COI defined in our study (entrepreneurial process, mobility, short innovation cycles, affinity to collaborate, international strategies, and recycling of people, capital, and ideas) can have benefits that go beyond the cluster. While these behaviors evolve out of individual actors striving to succeed, they build a culture of collaboration. The cross-industry horizontal networking of peers, a win-win approach, and shared belief that the world is not a zero-sum game can enable a region to be more competitive over a sustained period. While perhaps not surprising in describing Silicon Valley, this evolved culture has also manifested in traditionally more rigid societies. In Taiwan, for example, the collaboration between the domestic PC and semiconductor industries that evolved as they each matured allowed them, working together, to form more imbedded links with their U.S. customers and to pivot into design competencies, evolving the entire cluster toward a more stable, robust, and globally competitive U.S.-Taiwan super-COI. Collaboration among universities, government, and the private sector in Recife allowed the building of a politically independent high-tech cluster that has buoyed its regional economy. Collaboration within London's high-tech cluster as well as its cross-fertilization with other sectors of London's economy helped it weather economic downturns more successfully than other parts of the UK. Similarly the regeneration of the 22@ district in Barcelona has helped that city maintain its regional (and global) economic leadership. The collaborative university-private sector-government initiatives in Germany, Belgium, Israel, and Japan are also helping maintain and expand their regions' competitive status in the global economy. The essential COI characteristics have also proved valuable as formative and cohesive tools in regions such as China and Latin America that are struggling with formidable societal and institutional challenges.

Finally, COI can be platforms for resiliency and diversification of established ecosystems. Silicon Valley has followed this path, expanding to a wide array of information technology activities, and even to new industries such as biotechnology, renewable energy, and automobile manufacturing. Similarly, the Porto Digital is diversifying to "creative economy" activities that rely on information technology and leverage the innovation ecosystem already in place. Barcelona has seen a comparable diversification with 22@ spawning a new collection of media, ICT, Design, Energy, and Biotech companies. This is a surprising insight for those who have preached the old gospel of clusters defined by industry. A cluster defined by process (i.e., entrepreneurial process) is far more complex, flexible, and perhaps more enduring than vertical clusters based on specific industries. Linking with or developing Clusters of Innovation should be in on the agendas of all who are interested in regional and national economic development.

Lessons for Businesses, Entrepreneurs, and Venture Investors

What strategies can be deployed by businesses, entrepreneurs venture investors to exploit the advantages of Clusters of Innovation and overcome the challenges of building businesses in their absence? It is well understood that the location of a business affects its strategies and viability. Simple examples abound, from location-specific natural resource exploitation to the old saying "Only three things matter in retail: location, location, location!" So what is the innovation corollary? This study suggests several strategies for connecting businesses to COI.

Locate the Business in an Innovation Cluster

The obvious must be stated. It is clear that startup technology businesses derive cluster benefits from locating in a Cluster of Innovation. Proximity to resources, investors, and all the mobilized and aligned components of the cluster enable the rapid cycles of experimentation, learning, and adjustment that are so necessary for agility in evolving a powerful and scalable business. The best entrepreneurs and venture investors will exploit this location benefit as a strategy, using proximity to resources and markets to accelerate rapid learning and testing cycles—and, after validation, to accelerate scaling. Because of the cluster-enabled lower transaction costs and relatively fluid ability to adjust strategy and resources, more apparently "risky" business strategies can be deployed to competitive advantage.

Remote Ventures Should Build Bridges

There are many reasons why technology ventures will not chose or even consider locating in a Cluster of Innovation. Such things as founder preferences, lifestyle, and proximity of historically important resources can anchor ventures of great potential in a location remote from an innovation hub. For these ventures, clusters benefits can be achieved through global interconnections, as the cases of Israel, Taiwan, and Belgium illustrate. Bridges to Clusters of Innovation can take several forms. One way is to seek business partners or investors who are located in COI, but it is important to place a priority on associates who understand how to exploit their location benefits to mutual advantage. These connections can progress from the "weak ties" of casual associations to more solid bridges of "durable bonds" (contractual relationships), and sometimes to "covalent bonds" (mutually dependent and integrated businesses).

Consider Multi-Location Strategies

As the cases of London, Belgium, Germany, and Israel illustrate, emerging ventures and their investors can bridge to innovation clusters though multi-office strategies. Though this may seem obvious, what is remarkable is the early stage at which these location adjustments are made and the functions residing in each. The prototypical example is the technology venture where the initial founders are a technical team that focuses on product development. Potential investors from remote COI often encourage that the venture be relocated to their proximity for the perceived cluster benefits and the increased ease of investor engagement (advice, guidance, assistance recruiting, and investment governance). The technical team is often left in its original domicile to not disrupt these critical competencies or the pace of product development, but the chief executive, financial, marketing,

and sales functions are placed in the new COI office. This approach has become quite widespread, to the extent that it is now initiated by entrepreneurial ventures as a strategy for securing of venture financing. Another derivative of this strategy is the participation of overseas teams in incubator and accelerator programs remote from their home domicile explicitly to access the perceived cluster benefits of that locale.

Embrace a Global Perspective Right from the Beginning

The term "born global" has come to mean addressing global markets right from the beginning. Our cases support this approach, but go further and identify the benefit of taking a global approach to both markets and resources. As discussed above, a class of venture investors and entrepreneurs are exploiting global venture investing to significant success. Further, technology sourcing has moved beyond the labor arbitrage of the recent past to true technology sourcing, increasing the opportunity for cross-border collaborations between major incumbents and emerging ventures. Such collaborations are delicate, but can be yet another point of access to cluster benefits.

Leverage Relationships with Universities, NGOs, and Governments

Many of our cases demonstrate the increasing recognition of the importance of the innovation economy and the enabling roles of universities, major corporations, governments, and NGOs. Entrepreneurs' and venture investors' strategies can embrace these resources to their advantage. Not all these institutions, no matter how well intended, are equally qualified or positioned to be of assistance. It is important to identify and leverage relationships with those that have global businesses or business perspectives and not restrictive regional agendas. It is also important that these be institutions of excellence. These collaborators will be sources of expertise, perspective, and accelerated learning. Also, their affiliation can enhance or tarnish the desirability of a relatively unknown early-stage venture. In establishing global interconnections, as in many things, you will be known by the company you keep.

Accelerate Global Strategies through Corporate Collaborations

Our cases indicated an increasing acceptance by major corporations of the potential to be derived from collaborating with, and at times acquiring, entrepreneurial ventures. Additionally, as the case of Intel highlights, major corporations are finding that supporting innovation ecosystem development is strategically important. The motives for such openness go beyond the classic "open innovation" focus on product, service, and talent acquisition to embrace fundamental strategic agility and intimacy with the daily entrepreneurial practices in a Cluster of Innovation. To benefit from this potential, entrepreneurs and venture investors need to increase the visibility of their ventures, strategically marketing their ventures activities and accomplishments globally, and positioning them as attractive sources of innovation insight and execution. For their part, major corporations need trained eyes and ears to bridge the gap between corporate needs and these opportunities. This is not a traditional business development or M&A function, but rather one that requires long-term commitment to specific COI to become active and trusted members of the cluster community.

In the cases observed, dedicated business units and personnel, such as corporate venture capital arms, have proven effective.

Deploy Business Models that Have Proprietary Ingenuity but are Readily Transportable

Accelerated by global trends toward a knowledge and digital economy, location is becoming less of a constraint for new high-tech ventures. At the same time, cluster benefits are becoming ever more apparent. This apparent contradiction is moderated by the emergence of an increasingly globally interconnected innovation economy, even for startup ventures. This concept is captured in the concept of the Global Network of Clusters of Innovation. Ventures that typify a Cluster of Innovation—namely, businesses that exploit intellectual property and innovative business models—have a relatively easy path for global dissemination, whether through singular efforts or through collaborations. This was demonstrated clearly in the cases investigated, such as the internet startups of London, Recife, or Tel Aviv. Entrepreneurs and venture investors should exploit this capability to rapidly scale validated business models.

Exploit and Reinforce Local Competencies

Entrepreneurs and venture investors naturally build on and exploit local competencies. It is just these capabilities that often enable the venture in the first place. The focus on being born global and interconnecting with COI must not do damage to these critical resources, It is these resources that differentiate the enterprise and make it uniquely valuable.

Questions and Challenges

After consideration of the lessons learned, the greatest contribution of this investigation may be to help frame key questions and challenges that must be addressed by practitioners and policy makers. Here are twelve questions that need to be considered:

Who takes the first step? Who leads?

It is satisfying to describe a Cluster of Innovation and divine its components, behaviors, benefits, and challenges. But how does one make it happen? Can one make it happen? If it is best that emergent forces dominate rather than prescriptive governments dictates, how do we proceed? Who should take the lead?

Can we all follow the same road map?

If we are to build on local strengths, not visions, localization of the framework may lead to chaos and a lack of coherent vision. If each community is following a localized emergent approach, how can they learn from each other and form a collaborative mission?

How do you manage "the commons"?[25]

It is natural for parties to lobby to secure resources and support for their own vested interests. The collaborative culture of a COI often encourages a gifting

economy, where an individual's stature is elevated by how one facilitates networking and useful connections. How can this trend be leveraged to create a win-win culture that looks after the common resources that do not fall under a single jurisdiction?

How can you build on local strengths?

What does it mean to build on local strengths? Are all "strengths" equally relevant? How and which does one choose, prioritize, support? What should be the criteria, e.g., relevance to immediate local competitiveness or relevance to longer-term global opportunities?

What is the role of the public sector, including universities and local and national government?

There are many indirect stakeholders. Their importance is one of the key findings demonstrated in this volume. How does one motivate concerted action? What is the role of each? How are they distinct? How can synergies be amplified and competiveness avoided? How does one sustain a cohesive effort over the longer term? Private sector actors will be motivated by self-interest with relatively short payback cycles. What works in the public sector?

How does the role of public sector stakeholders differ over the life cycle of the cluster of innovation?

We have seen diverse public sector contributions to the emergence of clusters of innovation. Some of the most profound have been unintended, i.e., massive long-term investments in defense. Others have been explicit, overt, and targeted. When is each appropriate? How can the benefits of unintended actions be anticipated, reinforced, and harvested as the seeds of things to come?

Are we talking only about economic development or must we include social development as well?

Do we need to consider the social economic climate of the emergent cluster? Does this question help us distinguish a role for the public administration? What kinds of social sector innovations are supportive of building a Cluster of Innovation? How does one prioritize between social needs and economic development?

How should we take into account industry trends?

Regional economic development deals with relatively long time horizons. At the same time, industry cycles and trends—especially in ITC, media, and Internet—are volatile and brief. What do we do when the current benefits of the boom in the digital economy fades? Many emergent clusters are enabled by the lowered capital requirements for building ITC companies. Cloud computing infrastructure and global customer access enabled by the Internet and cell phone have reduced the chokehold of capital on entrepreneurial endeavor. Is this just a passing moment? How does a cluster dependent on the digital economy achieve scale and sustainability?

In export dependent clusters, is building and exporting successful small companies and technologies a viable strategy for a sustainable cluster?

London and Israel, for all their success, have been frustrated by the tendency for their best emerging companies to migrate overseas, through acquisition or foreign IPOs. In Brussels, iMinds has embraced this process as a means of creating a positive feedback loop that hopefully will ultimately integrate its region into the global innovation economy. Will this work? Is this a wise strategy? Many jobs will end up overseas, but exits from the region based on fresh investment or acquisition may spur more entrepreneurship locally. In addition, as successful entrepreneurs repatriate, reinvest, and provide linkages back to the larger ecosystem, an ever increasing base of successful entrepreneurial ventures will be enabled. Israel has had great success with this approach, but now seeks to retain growing startups that have the potential to become large companies in the belief that such domestic growth does more to distribute jobs and wealth to a broader sector of society, both geographically and socially, than does early acquisition. How will these trade-offs be assessed and incentivized? Indeed, does the local region have a choice?

Is being dependent on international linkages worth the vulnerabilities it engenders?

Close international linkages, such as the Taiwan and the Israel super-COIs, make local economies vulnerable to distant economic volatility and perhaps leave the local cluster overly dependent on a few remote partners. This also raises the risk of having local companies not fully benefit from the economics of the entire value chain, e.g., stuck in relatively lower value manufacturing, with shrinking profit margin and lacking the value of end-user intimacy and the opportunity for independent innovation.

How do you interact with government when it is more of a hindrance that a help?

How does one create an innovation ecosystem with constituents that engender entrepreneurial behaviors when the state or state-owned enterprises are a hindrance? Comparable challenges may exist in economies and industries dominated by large incumbents with monopolistic powers, not just in the end-user market, but up and down the supply chain. Is China a special case or can lessons be drawn from its experience?

Certain environments, as in Latin America, are challenged with a fundamental erosion of the rule of law, increasing corruption, and violence. In such circumstances, can successful innovation communities be sustained? Can successful innovation communities help create and sustain the fundamental enabling conditions?

In our cases, we have seen government take many roles, including enabler, convener, banker, investor, landlord, educator, and enforcer. When and how is each of these tools most effective and appropriate? When do they interfere with natural market forces that may be more effective and should be reinforced rather than competed with? How can government effectively collaborate with all parties, including the NGO sector, to encourage and enable dissemination of best entrepreneurship and innovation practices?

What role can and should leading multinational firms play?

On the presumption that private enterprise should always operate in its enlightened self-interest, should these concerns be on the proactive agenda of the CEOs of global industry leaders? When and how should they be engaged in a dialogue about encouraging innovation ecosystems in their communities of interest? What is the appropriate motivation for engagement? Is it simply "Corporate Social Responsibility" or can these actions be justified on the basis of enhancing shareholder value?

Moving Forward

What have we learned? We have observed how certain communities have resources and manifest behaviors that enhance the innovation potential of their economies, and also how these communities interact with similar communities to offset deficits, leverage core competencies, and realize value for their constituents. We have integrated these observations into pre-existing regional economic cluster theory, and established an enhanced framework for understanding Clusters of Innovation and the global networks that connect them. We have seen the constraints that challenge certain communities. We have seen how top-down government and institutional action and bottom-up emergent behavior by entrepreneurs and investors can meet and overcome these challenges. We have learned some generalizable lessons and frameworks that can help inform government policy makers, investors, entrepreneurs, and managers of global enterprises. As importantly, we have begun a process of identifying questions that confront those who seek to understand the Cluster of Innovation process and put it to work.

Given these opportunities and challenges, how are we to proceed? For entrepreneurs, investors, and leaders of mature enterprises, we have identified strategies to access and benefit from COI. For governments and policy makers, we have identified key strategies toward enhancing regional innovation cluster benefits. Further, we have learned that any intention for radical redesign of regional economic systems to emulate Silicon Valley, or any other archetype, must be tempered by a core lesson from study: That the most profound enabling pre-conditions may be the unintended consequence of others actions years before. This humbling observation reminds us that supporting innovation ecosystems is as much a journey of discovery as a course of action, that we have to understand where we are before we chart a course ahead, and that the uniqueness of each situation calls for behavior characterized by experimentation, short feedback cycles, and attention to open and informal communications at all levels of the hierarchy.

Notes

1. This article is derived from this collaboration, recently published and more fully documented in a volume edited and co-authored by the author: J.S. Engel, *Global Clusters of Innovation: Entrepreneurial Engines of Economic Growth around the World* (Northampton,MA: Edward Elgar, 2014).
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3. A. Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1994).
4. J.S. Engel and I. del-Palacio, "Global Networks of Clusters of Innovation: Accelerating the Innovation Process," *Business Horizons*, 52/5 (September 2009): 493-503.
5. J.S. Engel and I. del-Palacio, "Global Clusters of Innovation: The Case of Israel and Silicon Valley," *California Management Review*, 53/2 (Winter 2011): 27-49.
6. H. Blackwell, "Emerging Energy and Intellectual Property—The Often Unappreciated Risks and Hurdles of Government Regulations and Standard Setting Organizations," *The National Law Review*, May 22, 2012, pp. 5-22.
7. W.R. Kerr, "Clusters and Startup Location Choice," lecture at the Harvard Business School Faculty Research Symposium, May 1, 2010.
8. Various sources including PriceWaterhouseCoopers/National Venture Capital Association MoneyTree Report, based on data from Thompson Reuters (2013) and Dow Jones DJX Venture Source (3Q 2013)
9. Steve Wozniak interview, Jessica Livingston, *Founders at Work: Stories of Startups' Early Days* (Berkeley, CA: Apress, 2007).
10. H. Stevenson, *New Business Ventures and the Entrepreneur* (Boston, MA: Irwin/McGraw-Hill, 1999).
11. C.M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Boston, MA: Harvard University Press, 1997).
12. G. Knight and S.T. Cavusgil, "The Born Global Firm: A Challenge to Traditional Internationalization Theory," in T.K. Madsen, *Advances in International Marketing*, Vol. 8 (Greenwich, CT: JAI Press, 1996), pp. 11-26; P.P. McDougall, B.M. Oviatt, and R.C. Shrader, "A Comparison of International and Domestic New Ventures," *Journal of International Entrepreneurship*, 1/1 (March 2003): 59-82.
13. According to PrivCo, a market research firm specializing in business and financial data on major non-public companies, calculated based on the shares held by insiders a day after the Twitter IPO.
14. A. Saxenian, *The New Argonauts: Regional Advantage in a Global Economy* (Cambridge, MA: Harvard University Press, 2006).
15. Engel and del-Palacio (2011), op. cit.
16. Engel (2014), op. cit.
17. Including Silicon Valley, Munich, Barcelona, and Tokyo.
18. Including Belgium, Israel, Recife, and Minas Gerais.
19. Taiwan and aspects of London and Belgium.
20. Including Silicon Valley, Recife, and to some extent Munich. However, the EU in many ways is still an aggregation of markets segmented by language, culture, and custom. This is especially poignant in consumer-facing internet applications and media. While the technology and legal arrangements make national borders less relevant, consumer attributes still create barriers to ubiquitous dissemination across these boundaries.
21. Such as Belgium, Israel, and Taiwan.
22. Such as Munich, Belgium, Barcelona (in the long term), China, and Medellin Columbia.
23. Such as Monterrey Mexico, Barcelona (in the short term), Medellin Colombia.
24. This point is powerfully identified and illustrated by Saxenian in *Regional Advantage* [(1994), op. cit.].
25. Peter Barnes describes "the commons" as a set of assets that have two characteristics: they are all gifts; and they are all shared. A shared gift is one we receive as members of a community, as opposed to individually. All have access, but no one party is responsible for is custody and care. Examples of such gifts include air, water, ecosystems, languages, music, holidays, money, law, mathematics, parks, and the internet.

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